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Integrating UN Sustainable Development Goals into Campus Planning: Pathways for Higher Education Institutions

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Abstract

This research article explores the significant role of higher education institutions (HEIs) in contributing to the Sustainable Development Goals (SDGs) by analyzing their sustainability initiatives through the lens of the GreenMetric University Sustainability Rating. It scrutinizes the commitment of prominent universities across various continents to environmental stewardship, focusing on essential areas such as infrastructure, energy efficiency, waste management, water conservation, and sustainable transportation. The study examines the sustainability practices at notable institutions including the University of Indonesia (UI), Wageningen University & Research (WUR), the American University in Cairo (AUC), Lincoln University, the University of California, Davis (UC Davis), and the University of São Paulo (USP). It organizes these efforts into six main domains: Campus and Infrastructure, Energy and Climate Change, Waste Management, Water Conservation, Transportation, and Education and Research, providing a detailed analysis and recommendations for enhancing campus sustainability. Through a comparative analysis, presented in a structured format, the article highlights exemplary practices and aims to serve as a blueprint for other universities seeking to integrate sustainability into their operations. This research underscores the pivotal role of higher education institutions (HEIs) in driving sustainable solutions and aligning with global environmental objectives, advocating for a systematic and scientific integration of sustainability principles across university operations and curricula. It offers an in-depth analysis of current sustainability trends in higher education, stressing the critical need to motivate institutions towards greater sustainability commitments and to foster the development of leaders and innovative approaches for a sustainable future.

1. INTRODUCTION

Global warming, often called climate change, represents a formidable challenge to the health and stability of our planet and its inhabitants. This phenomenon is primarily driven by the accumulation of greenhouse gases, such as carbon dioxide and methane, in the Earth's atmosphere. These gasses function like a thermal blanket, trapping solar heat and incrementally elevating global temperatures. The ramifications of this process are multifaceted and profound, encompassing a spectrum of environmental and socio-economic impacts. These include the gradual rise of sea levels, the accelerated melting of glaciers, an increase in the frequency and severity of extreme weather events, significant ecological alterations, and a myriad of threats to human health and livelihoods. The primary sources of these greenhouse gas emissions are deforestation, the combustion of fossil fuels, and various industrial activities. A concerted effort at local, national, and international levels is imperative to combat global warming. This includes a transition towards renewable energy sources, enhancement of energy efficiency, adoption of sustainable land use practices, conservation of ecosystems, and a commitment to reducing overall greenhouse gas emissions.

Sustainability refers to the judicious use of resources to meet current needs without compromising the ability of future generations to meet their own needs. Although the word sustainability, which originates from the Latin word 'sustinere', has been used in many meanings in dictionaries, it is mainly used in the

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meanings of sustaining, providing, continuing, supporting, and existing [1]. It encompasses a holistic approach, integrating environmental stewardship, economic viability, and social equity to foster a balanced and enduring development. The importance of sustainability lies in its capacity to ensure long-term ecological balance, safeguarding natural systems and resources crucial for the survival and prosperity of humanity. Moreover, sustainability is pivotal in addressing global challenges such as climate change, resource depletion, and social inequality, thereby ensuring a viable and equitable world for future generations.

Additionally, the United Nations' Sustainable Development Goals (SDGs) [2] play a crucial role in this context. These goals, established in 2015, are a universal call to action aimed at addressing the world's most pressing social, economic, and environmental challenges through 17 interconnected objectives. The SDGs endeavor to eradicate poverty, ensure education and gender equality, provide clean water and sanitation, develop sustainable cities and communities, and, notably, combat climate change. Goal 13, for instance, places a spotlight on the need for immediate action against climate change. The SDGs call for a unified effort to reduce greenhouse gas emissions, enhance renewable energy usage, bolster resilience against climate-related hazards, and promote sustainable consumption and production patterns. Through the implementation of strategies that increase energy efficiency, expand renewable energy use, and foster low-carbon economies, countries can significantly reduce their greenhouse gas emissions. Additionally, sustainable practices in agriculture, forestry, and urban development can contribute to climate change mitigation while also supporting other SDGs, such as zero hunger, life on land, and sustainable cities and communities. In conclusion, integrating climate action into broader sustainable development initiatives is essential to ensure a prosperous future for all while safeguarding the integrity of our planet.

The concept of a university or college campus encompasses not only the physical space but also the facilities that are an integral part of academic and extra-curricular activities. The term 'campus' was used in America in 1746 for Princeton University [3]. This comprehensive space includes but is not limited to, academic buildings, classrooms, libraries, laboratories, residential halls, sports facilities, and additional areas dedicated to various student activities. Within these confines, a campus serves as a dynamic hub for learning, research, social engagement, and community involvement. It acts as a crucible for the academic and personal development of students, educators, and staff, fostering an environment conducive to collaboration and intellectual growth. Moreover, the presence of green spaces, walking paths, and recreational areas significantly enhances the quality of life for those residing on or frequenting the campus. Additional facilities such as administrative offices, dining services, student support centers, and cultural or artistic venues contribute to the holistic nature of a campus environment. The emblematic significance of a university campus extends beyond its physical boundaries. According to Alshuwaikhat and Abubakar [4], because of their size, population, and the many complex activities on campus, universities may today be considered "small cities" because of their significant direct and indirect environmental effects.

In the context of sustainability, university campuses assume a pivotal role. Sustainable campuses serve as living laboratories where sustainable practices and theories are not only taught but actively implemented and observed. Ali and Anufriev [5] state that the concept of a green university is inspired by environmental sustainability, encompassing the efficient use of natural resources, effective environmental management, pollution prevention, and economic considerations of profit and cost within the broader context of the environment, economics, and society. According to Velazquez et al [6] a sustainable university is defined as “A higher educational institution, as a whole or as a part, that addresses, involves and promotes, on a regional or a global level, the minimization of negative environmental, economic, societal, and health effects generated in the use of their resources in order to fulfill its functions of teaching, research, outreach and partnership, and stewardship in ways to help society make the transition to sustainable life-styles.” Alshuwaikhat and Abubakar [4] also state that “A sustainable university campus should be a healthy campus environment, with a prosperous economy through energy and resource conservation, waste reduction and an efficient environmental management, and promotes equity and social justice in its affairs and export these values at community, national and global levels”.

Furthermore, sustainable university campuses act as exemplars of practical solutions and best practices that can be emulated by other institutions and communities. Through the adoption of energy-efficient buildings, renewable energy systems, comprehensive waste management programs, and initiatives promoting sustainable transportation, these campuses demonstrate the feasibility and benefits of sustainable practices. This not only stimulates innovation and research in sustainable technologies and practices but also encourages multidisciplinary collaboration among students, educators, and researchers to address complex environmental challenges. By adopting sustainable practices, these campuses significantly reduce their carbon footprint, resource consumption, and overall environmental impact. In doing so, they not only embody the principles of sustainable living but also inspire and encourage broader societal adoption of these practices. Sustainable university campuses are not only centers of education and inspiration but also serve as catalysts for promoting sustainability within and beyond their campus borders.

LEED (Leadership in Energy and Environmental Design) [7] and BREEAM (Building Research Establishment Environmental Assessment Method) [8], are renowned rating systems that play a pivotal role in the evaluation and certification of sustainability in buildings. The LEED system, established by the U.S. Green Building Council, is a comprehensive framework designed to assess the green credentials of buildings, encompassing the entirety of their lifecycle from design and construction to operation and maintenance. Its assessment criteria are multifaceted, focusing on energy efficiency, water usage, indoor air quality, and material selection. On the other hand, BREEAM, originating in the United Kingdom, offers a similar yet distinct approach. It provides a holistic evaluation of the environmental and social impacts of buildings, incorporating a broad range of categories such as energy, water usage, waste management, the surrounding environment, and transportation infrastructure. This system places a significant emphasis on the broader ecological footprint of construction projects.

GreenMetric World University Sustainability Rating (WUR) [9], introduced by the University of Indonesia [10], plays a pivotal role in the realm of higher education by providing a specialized tool for assessing and benchmarking the sustainability of university campuses globally. Established in 2010, this rating system evaluates a wide range of aspects including infrastructure, energy and climate change policies, waste management strategies, transportation systems, and the quality of sustainability education. It serves not only as a tool for measuring current practices but also as a catalyst for ongoing improvement in campus sustainability. The system advocates for the adoption of energy-efficient technologies, the use of sustainable materials, waste reduction initiatives, and the establishment of comprehensive environmental management systems. These recommendations aim to enhance the sustainability of building and campus operations, thereby reducing environmental footprints and contributing to a sustainable future. The GreenMetric platform fosters a competitive and collaborative environment among universities worldwide, emphasizing global participation and raising environmental awareness in the academic community. Lauder et al [11] state that in shaping the GreenMetric WUR, the ranking design team was influenced by the holistic sustainability focus of the Holcim Awards [12], the localized green building practices of GREENSHIP [13], the extensive campus sustainability metrics of STARS [14], and the broad evaluative approach of the College Sustainability Report Card [14], integrating these diverse perspectives to assess universities' comprehensive efforts in environmental, social, and economic sustainability. Also, Hamzah et al [16] state that the methodology of GreenMetric is closely intertwined with the United Nations' Sustainable Development Goals (SDGs), demonstrating a significant alignment between the two frameworks.

Annual rankings are determined by the aggregate scores that higher education institutions garner through GreenMetric evaluations, which span various categories, each with its own set of weightings: Setting and Infrastructure (SI) at 15%, Energy and Climate Change (EC) initiatives at 21%, Waste (WS) at 18%, Water (WR) at 10%, Transportation (TR) at 18%, and Education and Research (ED) at 18% [17]. As detailed in Table 1, the number of indicators, points, and the percentage contribution of each category to the total points are meticulously outlined, with the total score being 10000 [18]. Setting and Infrastructure (SI), which assesses open space, vegetation, and sustainability budget; Energy and Climate Change (EC), focusing on energy efficiency, renewable sources, and greenhouse gas reduction; Waste (WS), which looks at waste management practices; Water (WR), evaluating water conservation and pollution control;

Transportation (TR), assessing vehicle policies and zero-emission initiatives; and Education and Research (ED), which measures the integration of sustainability into courses, research, and community engagement. Each category comprises various indicators, such as the use of energy-efficient appliances, 3R waste programs, water recycling, shuttle services, sustainability courses, and research funding, aiming to provide a comprehensive overview of a university's sustainability efforts. This detailed and encompassing approach underscores the pivotal role that universities play in championing and exemplifying sustainable practices, thereby contributing significantly to the global effort to promote sustainability within the higher education sector.

Table 1. *Indicators and Categories Suggested for Use in the 2023 Rankings by Greenmetric [18]*

Category	Number of Indicators	Points	% of Total Points
Setting and Infrastructure (SI)	11	1500	15%
Energy and Climate Change (EC)	10	2100	21%
Waste (WS)	6	1800	18%
Water (WR)	5	1000	10%
Transportation (TR)	8	1800	18%
Education and Research (ED)	11	1800	18%

Although GreenMetric is considered a pioneer in the field of sustainability assessment within higher education institutions, it has been subject to critique by experts on several fronts, highlighting areas in need of methodological refinement and greater scientific rigor to enhance its reliability and applicability in guiding sustainability policies and practices in universities globally. The critical review of the GreenMetric methodology by Ragazzi and Ghidini [19], highlights several issues including the absence of entry thresholds, lack of scoring bands, the relativity and high sensitivity of scores, and the incompleteness of the ranking in fully addressing the social and economic dimensions of sustainability, suggesting the need for methodological improvements for a more objective, transparent, and comprehensive assessment. Despite its recognition as a pioneering tool for assessing sustainability in higher education institutions (HEIs), the GreenMetric faces challenges in indicator selection, methodological stability, and long-term strategic planning utility, necessitating further refinement for enhanced transparency, objectivity, and scientific rigor. Boiocchi et al [20] argue that the UI GreenMetric ranking system's indicators for assessing global university sustainability often fall short, either due to irrelevance or lack of proper normalization against local context, highlighting the need for more accurate, unbiased indicators and emphasizing the complexity of ranking universities on sustainability while accounting for context-specific factors and data reliability. According to Karasan et al [21] the UI GreenMetric has globally promoted the green campus concept, especially in developing countries, yet necessitates updates, clearer priority guidelines, and new category-specific awards, while encouraging broader sustainability goals beyond ranking achievements, like the SDGs.

According to Atici et al [22], Muñoz-Suárez et al [23], and Marrone et al [24] aside from GreenMetric, the three other significant university sustainability rankings are the Academic Ranking of World Universities (ARWU), QS World University Ranking (QS Ranking), and Times Higher Education World University Rankings (THE Ranking). Launched in 2003 by Shanghai Jiao Tong University and now managed by ShanghaiRanking Consultancy, the Academic Ranking of World Universities (ARWU) [25] is the pioneering global ranking, annually listing the top 1000 research universities based on transparent,

objective criteria across six key dimensions. Launched by Quacquarelli Symonds (QS) in 2004, the 20th edition of the QS World University Rankings [26] evaluates 1,500 institutions across 104 locations, uniquely focusing on employability and sustainability, and provides a comprehensive comparison of global universities by region and subject on its website. The Times Higher Education (THE) World University Rankings [27], launched in 2004 and publishing independently since 2010, assesses 1,906 universities across 108 countries with 18 performance indicators across teaching, research environment, research quality, industry engagement, and international outlook, making it a leading global academic ranking for comprehensive university evaluation.

Despite its shortcomings and criticisms from some quarters, the GreenMetric ranking system is still considered by many to be the best tool for measuring sustainability in Higher Education Institutions (HEIs) for several compelling reasons. Firstly, it offers a comprehensive framework that encompasses a wide range of sustainability dimensions, including infrastructure, energy and climate change, waste management, water usage, transportation, and education. This holistic approach ensures that various aspects of sustainability are evaluated, providing a well-rounded assessment of an institution's sustainability efforts. Secondly, GreenMetric's methodology is transparent and globally applicable, allowing universities from around the world to participate and be evaluated on a common platform. This global standardization facilitates the comparison of sustainability practices across institutions, encouraging a competitive yet collaborative environment for improvement. Moreover, GreenMetric places a significant emphasis on innovation and continuous improvement by updating its criteria and weightings to reflect the evolving understanding of sustainability. This adaptability ensures that the ranking system remains relevant and encourages institutions to continually enhance their sustainability practices. The ranking system also serves as a powerful tool for universities to benchmark their performance against peers globally, identify areas for improvement, and strategize their sustainability initiatives. By participating in the GreenMetric ranking, institutions not only gain visibility for their sustainability efforts but also join a global network of universities committed to advancing sustainability in higher education.

Furthermore, GreenMetric's focus on data-driven assessments provides a quantitative basis for evaluating sustainability, making it easier for institutions to measure their progress over time and set concrete targets for future development. According to Ragazzi and Ghidini [28], the GreenMetric Ranking establishes a strong foundation for embedding sustainability principles in Higher Education Institutions, underscoring the significance of measuring efforts towards sustainability. In summary, despite its limitations and the critiques it may face, the GreenMetric ranking system's comprehensive, transparent, and adaptive approach, combined with its global applicability and focus on continuous improvement, makes it an exemplary tool for measuring and promoting sustainability in higher education institutions worldwide. Given these strengths, this research focuses on analyzing universities that rank first on their continents in the GreenMetric ranking system, examining their sustainability practices and achievements in detail.

2. METHODOLOGY

The primary objective of this research is to enhance awareness and understanding of sustainable development within university campuses, a crucial setting where students, as major stakeholders, spend significant time. This research aims to investigate key environmental challenges including global climate change, conservation of energy and water, waste recycling, and sustainable transportation, to educate and prepare future generations for a sustainable future. Additionally, it seeks to demonstrate the practicality of implementing sustainability initiatives in academic environments, focusing on cost-effective and efficient solutions for sustainable development challenges. A key aspect of the research is to promote a culture of long-term commitment to sustainability among university administrators, thereby addressing not only campus-specific environmental issues but also contributing to the broader discourse on global challenges such as air pollution, habitat loss, species extinction, climate change, and water scarcity. The primary data source was the GreenMetric website, recognized for its specialized focus on categorizing higher education institutions based on sustainability parameters. This platform provided valuable insights into the sustainability practices and policies adopted by these universities. Additionally, an extensive array of internet resources was utilized to gather a broader understanding of each university's sustainability efforts.

This included official university websites, academic publications, news articles, reports on special events, climate action plans, and annual sustainability reports. These diverse sources were instrumental in providing a comprehensive view of the sustainability initiatives at each institution.

The research methodology emphasized qualitative analysis, focusing on non-numerical data to understand the depth and nuances of each university's sustainability strategies. Content analysis was the primary analytical technique employed, enabling a systematic organization and evaluation of the collected data. This process involved a detailed examination of the sustainability content presented on the GreenMetric website and the integration of findings from various online sources. The study aimed to identify key themes, trends, and best practices in sustainability, as demonstrated by these leading universities. A significant component of the methodology was the in-depth review of relevant literature and documents related to university sustainability. For each university, documents were analyzed annually, covering the period from 2010 to 2023. This longitudinal approach allowed for an understanding of the evolution of sustainability practices over time and provided context to the current standings in the GreenMetric ranking. The 2023 GreenMetric ranking offered a comprehensive comparative analysis of 1183 universities from 84 countries, categorized into six geographical regions: Asia, Europe, Africa, Oceania, North America, and South America. This global perspective was crucial in illustrating the varied and extensive sustainability efforts undertaken by universities worldwide. The top-ranking universities in each region, as per the GreenMetric scores, were the focus of this study, showcasing their commitment to advancing sustainability within their campuses and curricula. This approach not only highlighted the achievements of these specific universities but also served as a benchmark for other institutions striving for sustainability excellence. The comprehensive data and insights gathered formed the basis of a detailed comparative analysis, presented in Table 2, to underscore the diverse sustainability strategies employed across different global regions [29].

Table 2. *GreenMetric Ranking by Region 2023 [29]*

Region	University	Country	Setting and Infrastructue Total: 1500	Energy and Climate Change Total: 2100	Waste Total: 1800	Water Total: 1000	Transportation Total: 1800	Education Total: 1800	Total Score 10000
ASIA	University of Indonesia (UI)	Indonesia	1325	1850	1575	950	1425	1800	**8925**
EUROPE	Wageningen University & Research (WUR)	Netherlands	1350	1825	1800	1000	1750	1775	**9500**
AFRICA	American University in Cairo (AUC)	Egypt	1060	1285	1800	1000	1400	1425	**7970**
OCEANIA	Lincoln University	New Zealand	1350	1425	1575	800	1700	1575	**8425**
NORTH AMERICA	University of California, Davis (UC Davis)	USA	1400	1900	1800	1000	1575	1750	**9425**
LATIN AMERICA	University of Sao Paulo (USP)	Brazil	1450	1775	1800	950	1700	1750	**9425**

3. FINDINGS

This study undertook an expansive examination of sustainability initiatives at six leading universities across different continents, identified through the 2023 GreenMetric University Sustainability Ranking. The methodological approach was multifaceted, combining qualitative analysis with a comprehensive review of online resources and the GreenMetric platform's data. The universities selected for the detailed study were the University of Indonesia (UI), Wageningen University & Research (WUR), the American University in Cairo (AUC), Lincoln University, the University of California, Davis (UC Davis), and the

University of São Paulo (USP). These institutions, representing their respective geographical regions, were chosen based on their high GreenMetric rankings and their diverse approaches to sustainability. Data on the sustainability practices of these six universities were meticulously compiled from their sustainability websites, dedicated web pages, sustainability and climate change reports, and scholarly articles on the topic. These sources offered a detailed insight into each university's commitment and actions towards sustainability. Efforts in the same domain were aggregated to present a unified perspective on the sustainability endeavors across these institutions. For each of the six universities, detailed information is presented under distinct headings, including their GreenMetric scores and their standings in previous rankings. Furthermore, the document elaborates on the specific dimensions of sustainability each university prioritizes, alongside a comprehensive description of the initiatives and measures they have implemented to address these areas. The narrative extends to discuss the future strategies and plans these institutions have devised to further their commitment to sustainability, indicating a proactive approach towards continuous improvement in environmental stewardship.

3.1. The University of Indonesia (UI), Indonesia/ASIA

According to GreenMetric's rankings, the University of Indonesia (UI) in Depok, Indonesia, has been recognized as the most sustainable university in Asia for the years 2022 and 2023 [30]. In sustainability, UI has achieved the highest ranking in the Asia region, achieving 8925 out of 10000 points. The university's accomplishment is a testament to its consistent commitment to sustainability in multiple areas, such as setting and infrastructure, energy usage, waste management, water conservation, transportation, and education. In terms of setting and infrastructure, UI boasts a suburban campus where 92% of the area is open space, with a significant 22% covered by forest vegetation. UI maintains 75% of its campus area for reforestation, emphasizing the importance of green spaces in urban settings. This emphasis on natural preservation, coupled with environmentally friendly landscaping, underscores the university's commitment to creating a sustainable environment. Furthermore, the campus's energy conservation initiatives are evident in its reduced electricity consumption, which saw a 6.9% decrease in 2018 compared to the previous year. UI's approach to renewable energy is multifaceted, incorporating solar panels for office and street lighting, hydrogen fuel cells, and wind turbines. The campus also makes extensive use of LED lighting and solar energy for air conditioning purposes. The integration of energy-efficient products increased by 25% in 2018 compared to 2017, with smart buildings constituting 25% of all floor space. These buildings are equipped with advanced features like CCTV, voice call systems, automatic fire alarms, and the strategic use of natural light and indoor vegetation. The UI library on the Depok campus, known as the "crystal of knowledge," was designed with sustainable principles in mind. It utilizes solar energy and is noted for its efficient use of electricity, water, and paper.

Regarding waste management, UI exhibits commendable practices. Approximately 50-75% of organic waste is utilized, predominantly processed through dry aerobic digestion, with the remaining 10% directed to the UI waste bank. Inorganic waste treatment and hazardous waste recycling are also effectively managed, with 50-75% of inorganic waste treated and 75% of hazardous waste processed and recycled. In terms of water management, UI has implemented numerous conservation and recycling measures. These include biophores, underground water tanks, and an artificial lake as water reservoirs. The university ensures that 50-75% of its water usage is derived from conservation sources, with 80% of the campus area dedicated to water conservation. Additionally, 75% of the total water volume is recycled, supported by an on-site water treatment facility and runoff collection systems.

Transportation at UI is geared towards reducing environmental impact. The campus has allocated 7% of its area to parking, a significant increase from the previous year, and offers a free shuttle service eight times a day. The university has also reduced its vehicle fleet by half since 2017. The campus promotes the use of zero-emission vehicles and bicycles, with 800 zero-emission vehicles available, representing a 78% decrease compared to the previous year. The university has developed over 20 kilometers of bicycle paths and provides shuttle buses to reduce vehicle use on campus. The introduction of campus bikes, available for rent to students, further promotes sustainable transportation. These initiatives are complemented by the provision of handicapped-accessible walkways with lights and motion sensors. In the realm of education, UI demonstrates a strong commitment to sustainability. The university supports 59 student

groups focused on sustainability, has hosted 198 sustainability-related events, and produced 300 publications on the subject. These efforts are backed by substantial financial commitment, with 27% of the university's total budget allocated towards sustainability initiatives. This comprehensive approach to sustainability at the University of Indonesia not only reflects its dedication to environmental stewardship but also serves as a benchmark for other institutions aiming to enhance their sustainability practices. By integrating sustainable principles into various aspects of campus life, UI stands as a leading example in the global effort to promote sustainable development in higher education [31-34].

3.2. Wageningen University & Research (WUR), Netherlands/EUROPE

Wageningen University & Research (WUR) in Wageningen, the Netherlands, has achieved significant recognition by being voted the world's most sustainable institution for the seventh time in both the overall and European rankings, according to the 2023 GreenMetric rating [35]. Achieving an impressive sustainability score of 9500 out of 10000, WUR integrates sustainability into its core research and teaching subjects. The Green Office Wageningen is instrumental in facilitating and supporting sustainable initiatives among students and faculty, engaging the community through various events and digital platforms like Instagram, Facebook, and LinkedIn. Under its Multi-annual Environmental Plan 2020-2022, WUR has set comprehensive sustainability targets across multiple domains. In the realm of energy, WUR is committed to achieving energy neutrality by 2030, with specific goals including a 2% annual energy saving and a reduction in natural gas usage. This commitment is evidenced by the establishment of solar farms, the utilization of 26 windmills in Lelystad for electricity generation, and the ambitious plan of powering all buildings and greenhouses with Aquifer Thermal Energy Storage (ATES) systems for heating and cooling purposes. More than 10,000 solar panels installed on campus buildings and grounds, along with wind energy, contribute to a significant portion of the university's energy needs.

Waste management at WUR aims for a 50% reduction in recyclable garbage, residual waste, and material consumption by 2030. In 2020, 98% of the university's waste was processed through 'useful recovery' methods, including recycling and energy recovery. Specialized waste units on campus facilitate the segregation of organic, paper, plastic, and other types of waste, promoting the repurposing of materials like paper cups and towels. Water management is another key focus area, with the university aiming to reduce water consumption and eliminate chemical pollution in effluents. Water-saving technologies are installed in new buildings, and regular inspections ensure the quality of water discharged into the sewage system. Efficient water treatment and purification processes, including the recovery of chemicals, are actively employed.

Biodiversity and soil management are integral to WUR's sustainability efforts. The Green Campus Vision guides the biodiversity policy, with regular assessments of the campus's flora and fauna. Soil quality is monitored consistently, and sustainable practices are incorporated into new construction projects, which prioritize features like insulation, thermal energy storage, green roofs, and solar panels. Air quality and asbestos management are also addressed, with the university committed to periodic emission testing and the systematic removal of asbestos-containing roofs and structures. In terms of procurement and mobility, WUR sets ambitious goals for emission-free business cars and sustainable supply chains. The university promotes eco-friendly modes of transportation, including electric vehicles, bicycles, and public transportation, aiming for a significant reduction in mobility emissions by 2030. Overall, WUR's holistic approach to sustainability encompasses energy efficiency, waste reduction, water conservation, biodiversity protection, sustainable construction, air quality improvement, and responsible procurement and mobility practices. This comprehensive strategy not only positions WUR as a global leader in sustainable practices within the academic sector but also serves as an exemplary model for institutions worldwide aiming to enhance their environmental footprint [36-40].

3.3. The American University in Cairo (AUC), Cairo/AFRICA

The American University in Cairo (AUC) in Egypt has garnered the title of the most sustainable university in Africa for the third consecutive year, as per the GreenMetric 2023 survey, achieving a sustainability score of 7970 out of 10000 in the Africa region rating [41]. This distinction highlights

AUC's extensive and multifaceted approach to sustainability, encompassing various domains such as buildings, landscape, water, energy, waste, transportation, and climate impact. At the forefront of AUC's sustainability efforts is its robust academic commitment, exemplified by the offering of 451 sustainability courses in the 2020-2021 academic year and the availability of a master's degree program in sustainability. The university has 13 sustainability-focused graduate programs spread across 32 departments, demonstrating a comprehensive integration of sustainability into its curriculum. Additionally, AUC's commitment to research in this field is substantial, with a budget of $23.5 million allocated for sustainability research and a dedicated Center for Environment and Sustainability Research.

In the realm of campus infrastructure, AUC has implemented an energy management system in its buildings, leading to a 50% reduction in ventilation and heating requirements. The architectural design of these buildings incorporates features such as large openings and wooden panels in windows to maximize natural ventilation and lighting while minimizing heat ingress, saving up to 40% in cooling energy. The installation of solar energy panels has contributed to a reduction of 77 tons of CO2 emissions. Moreover, the university is undertaking LEED certification efforts for its buildings, which feature green roofs, solar heating, energy-efficient doors and windows, motion sensors, counters, and sustainable landscaping with native flora. The university's landscape strategy includes 60 acres of gardens, 20 of which were designed by a renowned landscape architect. Emphasis is placed on air filtration and carbon emission reduction, with most of the trees and plants being cultivated in the university's agricultural research center. In 2021, the landscape and composting efforts led to the sequestration of 168 metric tons of carbon dioxide.

Water management at AUC involves limiting monthly water usage and utilizing treated wastewater for landscaping purposes, meeting 50% of the campus's overall water needs. The energy needs of the university are predominantly met by a cogeneration facility using natural gas, with energy usage monitored monthly and having seen a 19% reduction since the onset of COVID-19. Waste management includes 48 distinct waste stations across the campus and 35 filtered drinking water stations, which have eliminated the use of 7.4 million disposable water bottles. The transportation system at AUC offers 13 different routes to the university, including a shuttle service and a car-sharing program, with free parking for those participating in the latter. Addressing climate impact, AUC has released a carbon footprint report and implemented measures to reduce air conditioning, lighting, catering, and transportation emissions. The university also actively engages its student body in sustainability, evidenced by the existence of 25 student unions, the publication of 16 sustainability e-newsletters, and the organization of 47 related activities. Furthermore, AUC has established a special center dedicated to supporting students with disabilities, ensuring an inclusive and accessible learning environment. This comprehensive approach adopted by the American University in Cairo not only underscores its leadership in sustainability within the African region but also sets a benchmark for global institutions in integrating sustainable practices across various operational and academic aspects. By prioritizing sustainability in education, infrastructure, energy, water, waste management, transportation, and climate action, AUC demonstrates a commitment to fostering an environmentally conscious and responsible academic community [42-46].

3.4.Lincoln University, New Zealand/OCEANIA

Lincoln University in Lincoln, New Zealand, has been recognized as the most sustainable institution in Oceania for the years 2020, 2022, and 2023 according to the GreenMetric rankings [47]. In the 2023 Oceania regional rating, the university achieved a commendable score of 8425 out of 10000, reflecting its commitment to sustainability. Lincoln University has set two overarching long-term sustainability goals: to be a leader in sustainability education, research, and practice, and to achieve carbon neutrality by 2030, progressing towards zero carbon emissions by 2050. The first goal is divided into three key areas: education, research, and demonstration. In education, Lincoln University focuses on operationalizing and monitoring sustainability teaching activities, ensuring the graduation of competent individuals in sustainability, and encouraging participation in professional development. It aims to implement two sustainability laboratory projects each term and continuously enhance these educational objectives. Research initiatives at Lincoln University include supporting multidisciplinary sustainable research

projects annually, conducting comprehensive sustainability research, and developing the GreenMetric framework.

The demonstration aspect of this goal is realized through the Lincoln University Multi-Crop Energy Farm and two living lab studies conducted on university farms. These initiatives aim to reduce the carbon footprint through high-efficiency measures. The second goal encompasses green infrastructure, energy, water and biodiversity, transportation, and waste management. Green infrastructure initiatives involve conducting carbon audits, replacing fossil fuels with efficient heating systems like solar energy, benchmarking against sustainability criteria, assessing the cost of building life, and implementing sustainable asset management practices. In energy management, the university ensures energy efficiency in new infrastructure and utilizes renewable energy sources. It focuses on decommissioning a coal boiler, employing certified renewable energy solutions, and clearing obsolete structures. The university commits to quarterly reporting on campus energy production from renewable sources, increasing renewable energy usage, decreasing energy consumption per user, raising awareness about energy usage, and decommissioning diesel generators by 2030.

Water and biodiversity efforts include completing a landscape master plan and prioritizing projects such as the arboretum project and tree planting. Lincoln University also monitors water usage quarterly and engages in rainwater collection, greywater usage, and maintaining an artificial pond. Transportation initiatives at Lincoln University involve imposing a tax on air travel, transitioning to a 100% carbon-free university vehicle fleet by 2024, introducing a car-sharing app, providing special parking for electric vehicles, using carbon-free vehicles for field trips, offering bicycle storage, surveying transportation habits, promoting digital meetings, and increasing shuttle routes and hours. In terms of waste management, the university is committed to changing staff behavior and culture, making marketing materials more sustainable, reducing food waste by 75% by 2023, labeling recycling bins, implementing residential assistant and student housing programs, setting waste contamination targets, and training students in waste management. The university also focuses on consistent waste management across all areas, including lab waste, trash disposal training, minimizing packaging, eliminating single-use and petroleum-based plastic packaging, and promoting ecologically responsible waste disposal among students and employees. Through these comprehensive sustainability initiatives, Lincoln University not only advances its environmental stewardship but also sets a benchmark for other institutions in Oceania and beyond [48-51].

3.5. University of California, Davis (UC DAVIS), United States/NORTH AMERICA

The University of California, Davis (UC Davis), situated in Davis, California, has been recognized as the most sustainable university in North America for the seventh time, according to the 2023 GreenMetric rankings [52]. Scoring 9425 out of 10000 in the North American regional rating for 2023, UC Davis demonstrates a comprehensive approach to sustainability, encompassing 12 key areas: buildings, climate, food and beverage, labs, zero waste, procurement, diversity, equality and inclusion, energy, land management, nitrogen footprint, transportation, and water. UC Davis has achieved significant strides in sustainable building practices, with 40 buildings on the Davis campus receiving LEED certification and numerous older buildings undergoing energy retrofits. These buildings are equipped with sensor LED lighting, cool roofs, efficient windows, water-saving toilets and faucets, and strategies to educate campus users about energy conservation. The university aims to be carbon neutral by 2025 and has undertaken measures like switching off heating and cooling systems during holidays to reduce energy consumption. The university's infrastructure includes a wastewater treatment facility, an electrical substation, a central heating and cooling plant, water wells, surface water distribution, a public transportation system, and a combined heat and power plant in Davis, with a similar facility in Sacramento. Transitioning from fossil fuels to renewable energy sources is a key goal, involving efficiency improvements in the central heating system, the use of renewable and clean energy on campus, electrification of infrastructure, solar power plants, and carbon sequestration. In terms of food and beverage, UC Davis supports sustainable food choices, with 25% of campus food being sustainable. Initiatives like trayless cafeterias, hydration stations, and discounts for bringing their containers are part of a broader strategy that includes student food access, sustainable agriculture, campus-produced renewable foods, and food waste diversion.

UC Davis has also achieved its target for sustainable research laboratory evaluation. The university's commitment to waste reduction is evident in its goal to reduce per capita waste by 50% compared to 2015/16 by 2030, aligning with the zero-waste policy. This involves implementing reduce-reuse-recycle procedures, water filling stations, discounts for container use, and training programs. Reuse initiatives include outlets selling donated items and a biennial sale of abandoned bicycles. The campus recycles conventional materials like paper, cardboard, plastic, and compostable items, and participates in national waste-sorting events. The university's procurement practices focus on environmentally friendly products, with 74% of cleaning supplies being "green." Steps include purchasing less harmful products, establishing a system for identifying eco-friendly products, reducing courier numbers on campus, and replacing inefficient equipment. Diversity, equity, and inclusion are integral to UC Davis's sustainability efforts, with the Office of Diversity, Equity, and Inclusion setting the campus vision for these initiatives. Programs like the UC Fair Pay/Fair Work Plan and the Food Rescue Network are part of this commitment. Energy efficiency is a priority, with the university aiming to reduce energy usage by 2% per year and ensure that each building produces 100% clean energy by 2025. The campus has numerous solar panels, both ground-mounted and rooftop/parking, and is implementing energy efficiency projects like the replacement of the underground steam heat distribution system and a smart lighting system.

Land management at UC Davis involves maintaining 5300 acres with 14000 trees of more than 100 species, and 20% forest cover. The university's landscape includes orchards, vineyards, fields, pastures, and a living landscape adaptation strategy. Water management is a key focus, with the campus using approximately 15% of its water for landscape irrigation and 36% for agricultural irrigation. Efforts include transitioning to less water-intensive landscaping, efficient irrigation infrastructure, smart irrigation saving millions of gallons of water, mulch application to prevent evaporation, carbon sequestering landscapes, habitat mitigation areas, and wetland reserves for habitat protection. The university also boasts an arboretum, community garden, vineyard, student farm, and oak forest. UC Davis is the only U.S. institution to have measured its nitrogen footprint, underscoring its commitment to understanding and mitigating its environmental impact comprehensively.

In terms of transportation, the university aims for 50% of all new fleet vehicles to be zero-emission or hybrid by 2025, and a 10% reduction in private vehicle commuting. Already, a significant portion of the fleet is zero-emission or hybrid, and most staff and students use alternative commuting methods. Initiatives include on-campus housing enhancements, sustainable transportation infrastructure, bicycle rentals, repair stations, and expanded shuttle services. Water management strategies at UC Davis are aimed at reducing water usage by 36% by 2025. Actions taken in response to the 2014 drought, the use of recycled water in cooling towers, retrofitting a research fishery well, replacing outdated water armatures, and reducing irrigation are part of the comprehensive water conservation efforts. The Arboretum Waterway Maintenance and Improvement Project further exemplifies the university's commitment to sustainable water management. Through these extensive and varied sustainability initiatives, UC Davis not only leads in environmental stewardship in the North American region but also sets a global example for integrating sustainable practices in higher education institutions [53-56].

3.6. University of São Paulo (USP), Brazil/LATIN AMERICA

The University of São Paulo (USP) in São Paulo, Brazil, has been lauded as the most sustainable university in South America for the seventh time, according to the 2023 GreenMetric ranking [57]. Achieving an impressive score of 9425 out of 10000, USP leads the region in sustainability practices, examining its approach across eleven distinct categories: water and effluent, land use, sustainable buildings, energy, green spaces, and ecological reserves, transportation, greenhouse gas emission, fauna, management, solid refuse, and environmental education. Water conservation at USP is a key focus area, with the implementation of water-efficient fixtures such as low-flow faucets, toilets, and shower heads. The university also emphasizes rainwater harvesting, wastewater treatment, and reuse for non-potable purposes, complemented by leak detection, repair initiatives, and educational programs to promote water conservation awareness.

Land use strategies at USP involve the conservation of green spaces and ecological reserves. The campus dedicates 124 hectares to its ecological reserve out of a total area of 791 hectares. Sustainable landscaping practices include the planting of native trees, establishment of botanical gardens, use of efficient irrigation systems, and management of rainwater runoff through permeable surfaces. Additionally, sustainable agriculture methods promoting organic farming and biodiversity are actively pursued. In terms of sustainable buildings, USP strives for energy efficiency by maximizing natural lighting and ventilation, using energy-efficient appliances, and incorporating sustainable materials in construction. The university is also active in renewable energy generation, installing solar panels on campus rooftops and open spaces, and using energy-efficient lighting systems and motion sensors to control lighting. Faculty and students engage in research, workshops, seminars, and campaigns to raise awareness about renewable energy, energy conservation, and management.

The green spaces on campus are managed to promote biodiversity, facilitate wildlife movement, and conserve natural vegetation. USP employs environmentally friendly techniques such as composting and mulching to enhance soil health and water retention. The ecological reserves are used for conservation, restoration, research, and education about biodiversity, with collaboration from conservation organizations and public participation. USP's transportation policies support public transport, car-sharing, ride-sharing, and electric vehicle infrastructure, including charging stations. The university encourages alternative modes of transportation, providing incentives for sustainable commuting, and implementing policies to reduce private car usage on campus. Efforts to reduce greenhouse gas emissions include the application of energy-efficient technologies, carbon offsetting, and sustainable transportation and waste management strategies. For fauna conservation, USP preserves natural habitats on campus, conducting monitoring and research on biodiversity, and supporting wildlife corridors and green areas. Ecological restoration is a key component of the university's sustainability efforts. Overall, USP's comprehensive sustainability initiatives across various domains underscore its commitment to environmental stewardship and serve as a model for universities striving to integrate sustainable practices into their operations and culture [58-60].

4. RESULTS and DISCUSSION

Across the globe, universities are increasingly recognizing the critical importance of addressing environmental challenges and are actively integrating sustainable practices into their operations. This shared commitment to sustainability is evident in several key areas, reflecting a common approach among leading academic institutions worldwide. Firstly, universities are focusing on reducing greenhouse gas emissions and conserving vital resources such as energy and water. This commitment extends to promoting efficient waste management and recycling, alongside implementing sustainable transportation solutions. These efforts demonstrate a universal recognition of the environmental impact of university operations and a concerted effort to minimize this impact. Another significant similarity is the embrace of interdisciplinary collaboration. Universities understand that sustainability is a multifaceted issue that requires a holistic approach, encompassing various academic disciplines and stakeholders. To this end, many universities have established dedicated research centers and institutes with a focus on sustainability. These entities serve as hubs for collaboration and knowledge sharing, bringing together experts from diverse fields to address complex environmental issues.

Incorporating sustainability into the curriculum is another common topic. Universities offer various courses and initiatives designed to educate students about sustainable development and environmental stewardship. By integrating sustainability literacy into their educational offerings, these institutions are preparing students to be change agents in their communities and future professions. Students are encouraged to apply sustainable practices in their personal lives and professional careers, fostering a culture of environmental responsibility. Lastly, the formation of partnerships and networks is a crucial aspect of global sustainability efforts in higher education. Universities are engaging in collaborations to share best practices, undertake joint research projects, and collectively advance sustainability goals. These global networks facilitate the exchange of information and experiences, allowing universities to learn from each other and accelerate progress toward a more sustainable future. In summary, universities

worldwide share a common commitment to tackling environmental challenges and preparing future generations for responsible global citizenship. Their efforts in reducing emissions, conserving resources, fostering interdisciplinary collaboration, embedding sustainability in education, and forming global partnerships highlight a unified approach to creating sustainable university campuses. This research underscores the key actions considered essential to sustainability in the academic sphere and outlines recommendations for the ongoing development of university campuses in this critical field.

In university campuses, implementing sustainability measures is paramount for fostering an environment conducive to learning and ecological stewardship. Campus and infrastructure strategies such as enhancing green spaces and creating artificial water bodies are critical for improving biodiversity and environmental quality. Furthermore, the establishment of facilities catering to the diverse needs of the campus community, including those with disabilities, health centers, and robust safety systems, underscores a holistic approach to sustainability that integrates ecological, health, and safety considerations, thereby reflecting the academic institutions' commitment to creating a nurturing and responsible campus environment.

- Enhance campus green space and forest plantings to improve environmental quality and biodiversity.
- Create artificial pools and ponds to develop sustainable ecological areas, enhancing water quality and providing habitats for aquatic and terrestrial wildlife.
- Secure plant, animal, and wildlife genetic resources in dedicated conservation facilities for biodiversity preservation and educational purposes.
- Select and establish climate-appropriate flora specific to the campus region, promoting ecological resilience and sustainability.
- Develop accessible campus facilities for individuals with disabilities and special needs, ensuring inclusivity and ease of access.
- Establish comprehensive health facilities for campus users, offering medical services and wellness programs for physical and mental well-being.
- Implement robust safety and security measures, including emergency response systems and surveillance, to ensure a safe campus environment.

In university campuses, addressing energy and climate change is crucial, necessitating the adoption of sustainable and efficient practices. Key recommendations include implementing energy-efficient appliances, utilizing renewable energy sources, and incorporating green building designs to reduce environmental impact and carbon emissions. These measures, complemented by innovative solutions like vertical horticulture, sunshades, and green roofs, not only enhance campus sustainability but also contribute to the broader goals of environmental stewardship and carbon neutrality, positioning universities as leaders in the global effort towards a sustainable future.

- Implement energy-efficient appliances to reduce energy consumption and extend appliance lifespan.
- Utilize alternative energy sources like wind, solar, and thermal to decrease reliance on fossil fuels.
- Apply green and smart building principles in construction and renovation for enhanced energy efficiency.
- Aim to reduce greenhouse gas emissions, including carbon dioxide, to minimize the university's carbon footprint.
- Establish a clear zero-emission target roadmap to set and achieve sustainability goals.
- Develop innovative and effective university policies to address climate change challenges comprehensively.
- Integrate vertical horticulture on appropriate windowless facades to enhance urban green space.
- Utilize sunshades and light shelving to reduce energy usage in cooling and lighting.
- Use recyclable, bio-based, and biodegradable materials in construction projects to support sustainable development.

- Install awnings, coverings, and solar panels in parking lots to provide shade and generate renewable energy.
- Fit solar panels on suitable building rooftops to increase the campus's renewable energy production.
- Incorporate green roof designs in on-campus buildings for insulation, biodiversity, and aesthetic benefits.

In university campuses, effective waste management is a key component of sustainability, necessitating thoughtful and comprehensive strategies. Essential actions include reducing paper and plastic usage, implementing a robust reduce-reuse-recycle program, and expanding waste collection facilities, all aimed at minimizing environmental impact. Additionally, the safe treatment and disposal of various types of waste, including organic, inorganic, and toxic, are imperative for maintaining ecological integrity and public health, underscoring universities' vital role in fostering responsible waste management practices and promoting a sustainable campus environment.

- Reduce the use of paper and plastic by encouraging alternatives like thermos usage to minimize waste.
- Implement a comprehensive reduce-reuse-recycle (3R) waste management program on campus to foster sustainable waste practices.
- Expand and increase campus waste collection areas, integrating them into outdoor furniture for convenience and aesthetic appeal.
- Ensure safe storage, treatment, and disposal of toxic waste to protect the environment and public health.
- Develop a robust refuse recycling program to efficiently manage and recycle various types of waste materials.
- Treat organic, inorganic, and toxic waste effectively through specialized processes and facilities for minimal environmental impact.

In the context of university campuses, water sustainability is of paramount importance, necessitating the adoption of strategic measures for efficient usage and conservation. Key recommendations include implementing water conservation and recycling programs, creating manmade wetlands and natural water bodies, and installing greywater treatment systems, all aimed at reducing freshwater consumption and enhancing ecological health. Additionally, the adoption of water-saving technologies, effective sewage disposal, and the use of purified water for horticulture are crucial for maintaining environmental standards and fostering a sustainable campus ecosystem. These practices not only contribute to water resource management but also embody the university's commitment to environmental stewardship and sustainable development.

- Implement water conservation and recycling programs to efficiently manage and reduce water usage on campus.
- Create manmade wetlands and natural water bodies to enhance campus biodiversity and support water purification.
- Install greywater treatment systems in campus buildings for recycling wastewater for non-potable uses.
- Ensure proper sewage disposal to maintain environmental and public health standards.
- Incorporate water conservation mechanisms, such as low-flow fixtures and efficient irrigation systems, to minimize water wastage.
- Collect and utilize rainfall for irrigating man-made reservoirs, reducing reliance on freshwater sources.
- Use purified water for horticulture to conserve fresh water and promote healthy plant growth in campus landscaping.

Sustainable transportation within university campuses is a crucial aspect of their overall environmental strategy, necessitating specific initiatives to foster eco-friendly mobility. Key recommendations include promoting the use of zero-emission vehicles, substituting conventional service vehicles with electric

alternatives, and installing sufficient electric vehicle charging stations. Additionally, encouraging sustainable commuting practices such as public transportation, carpooling, and cycling, and enhancing the accessibility and inclusivity of campus transportation infrastructure are essential. These measures, aimed at reducing reliance on private vehicles and fostering a culture of sustainable transportation, not only contribute to a significant reduction in the campus's carbon footprint but also enhance the overall health and sustainability of the campus environment.

- Encourage the use of zero-emission vehicles on campus to reduce environmental impact.
- Substitute service vehicles with electric alternatives to promote sustainable transportation.
- Install electric vehicle recharge stations to support campus users' use of electric vehicles.
- Promote sustainable commuting practices among college students and staff to decrease reliance on private vehicles.
- Reduce the number of private automobiles and parking spaces on campus to discourage personal vehicle use.
- Increase the frequency and duration of shuttle services to offer convenient, eco-friendly transportation options.
- Expand accessible pedestrian routes on campus for people with disabilities and those with infant carriages.
- Develop bicycle and scooter paths to facilitate safe and sustainable mobility for all campus users.
- Propose a rental and maintenance station to encourage and support bicycle use on campus.

In the domain of education and research, universities play a pivotal role in advancing sustainability through a comprehensive approach that integrates sustainable practices into their academic fabric. Establishing a dedicated department for sustainability, incorporating sustainability courses into curricula across various disciplines, and increasing sustainability-focused academic activities are essential strategies. Furthermore, fostering collaborations with governmental bodies and releasing public sustainability reports enhances transparency and promotes the development of effective sustainability strategies, highlighting the crucial role of universities in shaping a sustainable future and fostering a culture of environmental stewardship within and beyond their campuses.

- Establish a dedicated department for sustainability to coordinate and integrate sustainability initiatives across the university.
- Incorporate sustainability courses into university curricula to educate students on environmental stewardship and sustainable practices.
- Increase academic activities related to sustainability, such as publications, seminars, and panel discussions, to foster research and dialogue.
- Create a sustainability concentration at undergraduate, graduate, or doctoral levels to provide specialized knowledge and skills.
- Enhance the number of sustainability-related activities, including student organizations and community service projects, for practical student engagement.
- Secure research funding, establish a budget, and define a long-term vision for sustainability research and development.
- Develop and maintain a university sustainability website as a central information resource on sustainability initiatives and achievements.
- Regularly release a public sustainability report to showcase the university’s sustainability efforts and progress.
- Collaborate with governmental bodies like the Ministry of Environment, Urbanization, and Climate Change to form an inspection council for shared expertise and resources.

To deepen the understanding of sustainability within higher education, a detailed study was conducted on universities recognized for their sustainability efforts across different continents. This research meticulously examined the sustainability practices of these institutions, identifying six fundamental categories essential for developing a sustainable campus. These categories were designed to cover the broad spectrum of sustainability, including energy conservation, waste management, and community

engagement, among others. To provide a clear model for other universities aiming to enhance their sustainability practices, the study organized the sustainability efforts of six leading university campuses into a comparative framework, presented in Table 3. This framework, carefully structured with headings and subheadings, offers an organized overview of each university's alignment with the established sustainability criteria. It is intended to not only highlight the specific sustainability initiatives of these institutions but also serve as a benchmark for other universities seeking to assess and improve their sustainability efforts. By presenting this comparative analysis, the study aims to foster a better understanding of effective sustainability practices and encourage their adoption across the higher education sector. The structured overview provided by the framework allows for easy comparison and serves as a benchmark for institutions worldwide to pursue comprehensive sustainability strategies, contributing to the global movement towards more sustainable campuses. Through this approach, the study supports the ongoing dialogue on sustainability in higher education, promoting a culture of environmental stewardship and social responsibility.

Table 3. *2023 Greenmetric Regional Leading Universities Sustainability Benchmark (1/2)*

	University	UI	WUR	AUC	LIN COLN	UC DAVIS	USP
	Region	Asia	Europe	Africa	Oceania	N.America	S.America
Campus and Infrastructure	Greening	✓	✓	✓	✓	✓	✓
	Artificial Pool	✓	✓	✗	✗	✓	✓
	Biodiversity Conservation	✗	✓	✗	✓	✗	✗
	Eco-friendly Landscaping	✓	✓	✓	✓	✓	✓
	Facilities for the Disabled	✗	✓	✓	✓	✓	✗
	Health Facilities	✓	✓	✓	✓	✓	✓
	Safety Measures	✓	✓	✓	✓	✓	✓
Energy and Climate Change	Energy efficient device	✓	✓	✓	✓	✓	✓
	Renewable energy source	✓	✓	✓	✓	✓	✓
	Green and smart building	✓	✓	✓	✓	✓	✗
	Reducing carbon footprint	✓	✓	✓	✓	✓	✓
	Zero emission policy	✗	✓	✓	✓	✓	✓
	Climate change policies	✓	✓	✓	✓	✓	✓
	Vertical garden	✓	✓	✗	✓	✓	✗
	Sun shading and light shelf	✗	✓	✓	✓	✗	✗
	Sustainable building materials	✓	✓	✓	✓	✓	✓
	Parking lot design	✗	✓	✓	✓	✓	✓
	Solar panel on the roof	✓	✓	✓	✓	✓	✓
	Green roof application	✓	✓	✓	✗	✓	✗
Waste Managment	Reducing paper and plastic	✓	✓	✓	✓	✓	✓
	3R program	✓	✓	✓	✓	✓	✓
	Waste collection areas	✓	✓	✓	✓	✓	✓
	Toxic waste management	✓	✓	✓	✓	✓	✓
	Waste recycling	✓	✓	✓	✓	✓	✓
	Waste treatment	✓	✓	✓	✓	✓	✓

Table 3. *2023 Greenmetric Regional Leading Universities Sustainability Benchmark (2/2)*

	University	UI	WUR	AUC	LIN COLN	UC DAVIS	USP
	Region	Asia	Europe	Africa	Oceania	N.America	S.America
Water Managment	Water conservation-recycling	✓	✓	✓	✓	✓	✓
	Artificial pool and pond	✓	✓	✗	✗	✓	✓
	Gray water recovery	✓	✓	✓	✓	✓	✓
	Sewage disposal	✓	✓	✓	✓	✓	✓
	Water-saving device	✓	✓	✓	✓	✓	✓
	Rainwater harvesting	✓	✓	✓	✓	✓	✓
	Use of treated water	✓	✓	✓	✓	✓	✓
Transportation	Zero emission vehicle	✓	✓	✗	✓	✓	✗
	Electric service vehicles	✓	✓	✗	✗	✓	✗
	Electric charging stations	✓	✓	✗	✓	✓	✗
	Shared vehicle	✓	✓	✓	✓	✓	✓
	Reducing vehicle parking	✓	✓	✓	✓	✓	✓
	Improving service delivery	✓	✓	✓	✓	✓	✓
	Accessible roads	✓	✓	✓	✓	✓	✓
	Bicycle paths	✓	✓	✓	✓	✓	✓
	Bicycle rental and repair area	✓	✓	✓	✓	✓	✗
Education and Research	Sustainability Office	✗	✓	✓	✓	✓	✗
	Sustainability curriculum	✓	✓	✓	✓	✓	✓
	Sustainability academic	✓	✓	✓	✓	✓	✓
	Department of Sustainability	✗	✓	✓	✓	✓	✗
	Sustainability events	✓	✓	✓	✓	✓	✓
	Sustainability vision	✓	✓	✓	✓	✓	✓
	Sustainability website	✗	✓	✓	✓	✓	✗
	Sustainability report	✓	✓	✓	✓	✓	✗
	Total : 49	**41/49**	**49/49**	**42/49**	**45/49**	**47/49**	**35/49**

5. CONCLUSION and RECOMMENDATIONS

In the context of advancing sustainability on university campuses, stainability on university campuses, as can be seen in the table, certain features such as protection facilities, sun shading and light shelves, and electric service vehicles, though currently implemented by only a few universities, warrant broader consideration and adoption. Protection facilities, essential for safeguarding the health and safety of the campus community, play a crucial role in ensuring a secure learning environment. Their importance is magnified in sustainable campus designs where the well-being of students, faculty, and staff is a priority. Therefore, integrating such facilities into more university campuses would not only enhance security but also contribute to the overall sustainability goals by promoting a safe and healthy academic environment. Sun shading and light shelves represent innovative architectural elements that significantly contribute to energy efficiency. By controlling and optimizing natural light, these features reduce the reliance on artificial lighting, thus lowering energy consumption and associated costs. Given their effectiveness in energy conservation and enhancing indoor environmental quality, their adoption in more universities could greatly advance campus sustainability efforts. Incorporating these features in new constructions or retrofitting existing buildings can be a strategic step towards reducing the carbon footprint of university campuses. The use of electric service vehicles is another sustainable practice currently limited to a few universities. Transitioning from fossil fuel-based vehicles to electric ones is a crucial step toward reducing greenhouse gas emissions and combating climate change. As universities often have numerous service vehicles for maintenance, security, and transportation, switching to electric vehicles can significantly diminish the environmental impact of campus operations. This transition not only aligns with global sustainability targets but also positions universities as leaders in adopting green technologies. In conclusion, while the implementation of protection facilities, sun shading and light shelves, and electric service vehicles is currently limited to a select few institutions, there is a compelling case for their broader inclusion in university sustainability plans. By adopting these practices, universities can enhance their environmental stewardship, reduce their carbon footprint, and set an example for sustainable campus management.

Promoting greener and more environmentally responsible approaches in campus planning, construction, and operations through sustainable design activities is crucial for reducing ecological footprints, resource consumption, and environmental impacts. The integration of sustainable design principles, encompassing energy-efficient systems, renewable energy utilization, water conservation strategies, eco-friendly materials, and the promotion of healthy interiors, is essential. Not only do these practices curtail operational costs and enhance the efficacy of campus facilities, but they also forge a healthier, more comfortable learning environment. Such sustainable design activities embody the institution's commitment to sustainability, motivating the campus community to embrace sustainable practices. These initiatives act as educational tools, showcasing sustainable technologies, and fostering opportunities for research, innovation, and interdisciplinary collaboration. By embedding these practices, campuses transform into living examples of sustainability, empowering individuals to adopt sustainable behaviors and promoting a culture of sustainability that extends beyond campus boundaries. In essence, sustainable design activities contribute significantly to building a more sustainable future by improving campus life quality and environmental preservation. Importantly, universities are not just centers of learning; they are pivotal in teaching and shaping a sustainable world. This role makes their commitment to sustainable design and practices not only commendable but fundamentally crucial for shaping a better future. Thus, it is crucial for universities to promptly and urgently embark on enhancing their sustainability practices, becoming exemplars for the wider community. This urgent action underscores our shared duty to protect our planet for future generations. It's a collective responsibility to safeguard our planet, reminding us all that the steps we take today shape the world we share tomorrow.

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